
621 SIGNAL PHASE CHANGE INTERVALS

These formulae shall be utilized for all signal phase change interval calculations from the date of approval of this policy on forward.

621.1 YELLOW AND ALL-RED CLEARANCE INTERVALS

The phase change interval is used so that the driver can react and safely decelerate and come to a stop before entering the intersection, or to clear the point of conflict before the conflicting traffic is released.

The exclusive function of the steady yellow interval shall be to warn traffic of an impending change in the right-of-way assignment. Yellow vehicle change intervals should have a range of 3 to 6 seconds. Excessively long yellow vehicle change intervals may encourage driver disrespect and unsafe operating practices.

An engineering study, 85th percentile speed data, and/or engineering judgment should be used to determine the approach speed. The posted speed limit may be assumed to be the approach speed when an engineering study or 85th percentile speed data is not available.

Experience has shown that a perception-reaction time of 1 second is realistic. Also, deceleration rates of 8 and 12 feet per second per second are the lower and upper limits for establishing vehicle change intervals. Typically drivers in large urban cities will exhibit higher rates of deceleration than will drivers of smaller towns and rural highways. For typical applications, a deceleration rate of 10 feet per second per second will be used in calculating the yellow vehicle change interval. The yellow vehicle change interval should be followed by an all-red clearance interval of sufficient duration to permit traffic to clear the point of conflict before conflicting traffic movements are released. **The length of the yellow vehicle change interval and the all-red clearance interval shall be established on the basis of these guidelines and engineering judgment.**

Phase Change Interval Calculation

- (1) Minimum yellow vehicle change interval = $t_1 + t_2$

$$\text{Reaction time } (t_1 = 1) + \text{Deceleration time } t_2 = \frac{1.47V}{2a}$$

For downgrades, use the following formula:

$$t_2 = \frac{1.47 V}{(2a + 64.4g)} \quad \text{where } g = \% \text{ grade divided by } 100$$

(downhill is negative grade)

PRE-CALCULATED YELLOW INTERVALS AT VARIOUS SPEEDS

Posted Speed Limit (mph)	Minimum Yellow Vehicle Change Interval (sec)
15	3.0
20	3.0
25	3.0
30	3.2
35	3.6
40	3.9
45	4.3
50	4.7
55	5.0
60	5.4
65	5.8

Signal controllers will not allow a lower value than
3.0 seconds to be utilized.

(2) All Red Clearance Interval = $t_3 = \frac{W + L}{1.47V}$

where: V = Posted Speed Limit in MPH
a = Deceleration Rate in feet/sec²
W = Intersection Width in feet, as defined in ARS 28-601
L = 20 feet

(3) Total Phase Change Interval = $t_1 + t_2 + t_3$

For deviations from the methods described herein, the length of the yellow vehicle change interval and the all-red clearance interval shall be approved by the Traffic Operations Engineer.

621.2 PEDESTRIAN INTERVALS

A. WALK Indication

The WALK indication should be at least 4 to 7 seconds in length so that pedestrians will have adequate opportunity to leave the curb or wheelchair ramp before their clearance interval is shown. A WALK interval of 4 seconds may be sufficient when fewer than 10 pedestrians per cycle are expected or where it is desired to favor the length of an opposing phase. A WALK interval of 7 seconds or more may be used for moderate to heavy pedestrian volumes.

B. DON'T WALK Indication

A flashing DON'T WALK indication shall always succeed the WALK indication to provide pedestrian clearance; the pedestrian clearance time shall be calculated from the following equation:

$$\text{pedestrian clearance time} = \frac{P}{w} - Y \quad (\text{rounded up to nearest whole second})$$

where: P = distance from curb to curb or center of wheelchair ramp to center of wheelchair ramp along center of crosswalk, in feet

w = normal walking speed, assumed to be 4.0 feet per second (fps)

Y = yellow vehicle change interval

Research verifies that 1/3 of all pedestrians cross streets at a rate slower than 4.0 fps and 15% walk at or below 3.5 fps. The timing of pedestrian signal indications near facilities that serve segments of the population with slower walking speeds should be calculated based on a slower walking speed. Such populations should be anticipated near shopping centers, convalescent or rest homes, therapy centers, elementary schools, etc. A walking speed of 3.5 or even 3.0 fps should be considered if senior citizens or school children are in the majority at a specific crosswalk. **Walking speeds below 4.0 fps shall be approved by the Traffic Operations Engineer.**

On a street which has an island or median of 6 feet or greater width, the pedestrian clearance time may be computed to provide only enough time to clear the crossing from the curb to the median; in such cases, an additional detector shall be provided on the island.

621.3 LEFT TURN SIGNAL TIMING

The general intent of the length of time allowed for the yellow interval and the red clearance interval for through traffic is an effort to prevent right angle collisions caused by through vehicles running the red light at high speed. Conversely, left turning vehicles are typically slower moving and their presence in the intersection is more obvious to opposing traffic movements. In view of the relative safety, left turning traffic requires less time for the yellow interval and the red clearance interval; this shorter period of time also promotes a shorter cycle length which produces more efficient traffic flow which ultimately further enhances safety.

In view of the above, it has been determined on the basis of engineering judgment that a three second yellow and a one second red clearance interval will be used following left turn phases at conventional intersections.

Complex Intersections

In instances where complex intersection geometrics exist, such as at single-point urban interchanges and at six legged intersections, longer timings may be appropriate.

The typical approach speed for left turning vehicles is assumed to be 25 mph or less. Therefore, a three second yellow clearance interval is appropriate in most cases. If speed samples indicate a higher approach speed may be more appropriate, then the yellow clearance interval may be calculated using the values of t_1 and t_2 as shown in Section 621.1.

The maximum all-red clearance interval for complex intersections should be calculated using the following formula:

$$AR = \frac{W + L}{1.47 V}, \quad \text{where}$$

AR = maximum length of red clearance interval, to the nearest 0.1 second;

W = left turning vehicle travel distance, in feet, measured from the beginning of area of conflict to the far edge of the area of conflict along the actual left turning vehicle path;

L = length of vehicle, assumed to be 20 feet; and

V = speed of left turning vehicle through the intersection, assumed to be 25 mph.

In the case of a left-turning vehicle at complex intersections, the distance through the intersection is measured along the arc traveled by the vehicle.

The typical travel speed for left turning vehicles is assumed to be 25 mph. A different speed may be used if speed samples indicate another speed is more appropriate.